

The logo for Porvair fuel cell technology features the word "porvair" in a bold, lowercase, sans-serif font. The letter "o" is replaced by a teal-colored circle with a white border. Below "porvair" is the phrase "fuel cell technology" in a smaller, bold, lowercase, sans-serif font. The background consists of several overlapping, curved bands of varying shades of green, transitioning from a light green at the bottom to a darker green at the top right.

**porvair**  
fuel cell technology

# **SCALE-UP OF CARBON /CARBON BIPOLAR PLATES**

Quarterly Report to the Department of  
Energy, May 19-22, 2003

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## ABOUT PORVAIR FUEL CELL TECHNOLOGY

A Division of the  
Porvair Advanced  
Materials Group

Core Technology in  
Advanced Porous  
Materials



# DOE PROGRAM OVERALL OBJECTIVES

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Project Objectives**

- Build and demonstrate a pilot facility capable of producing 300 bipolar plates per hour
- Develop a quality assurance plan for the facility
- Demonstrate plate properties that meet or exceed performance requirements over an extended period of use
- Perform cost analysis on plates produced with this facility and project costs to higher volume production

# DOE PROGRAM OBJECTIVES

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Phase I – Technology Development**
  - Develop materials to meet/exceed DOE and customer target specifications
  - Demonstrate plate performance in fuel cell testing at customers site
  - Investigate and develop processes having high production rate potential
  - Build a pre-pilot line capable of manufacturing 5-10 plates per hour

# DOE PROGRAM OBJECTIVES

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Phase II – Process Development and Demonstration**
  - Design and Build 300 plate/hour production line
  - Develop comprehensive quality assurance program
  - Demonstrate line capability through production metrics
  - Demonstrate 5000 hour plate operation with minimal performance degradation
  - Document product costs and project to higher volumes

# PHASE I SUMMARY

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Excellent Material Properties Achieved**
  - Electrical conductivity (thru-plane) 600 S/cm (DOE target > 100 S/cm)
  - Flexural strength (3-point bend) 4200 psi (DOE target > 610 psi crush)
  - H<sub>2</sub> permeability < 2x10<sup>-6</sup> cm<sup>2</sup>/sec (DOE target met)

# PHASE I SUMMARY

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Pre-Pilot line built and functioning**
  - Expanded line beyond scope of project to accommodate demand for plates in near-term
- **Extensive fuel cell testing performed**
  - Both single and multiple cell testing on regular basis since June 2002
  - Testing initially focused upon product demonstration
  - Recent tests performed to demonstrate new designs in transition to low cost bipolar plate products

## PHASE I SUMMARY

### *Scale-up of Carbon/Carbon Bipolar Plates*

- **High volume rate production processes investigated (on-going) in preparation for Phase II**
  - Methods for high speed material forming, pattern forming and thermal treatment investigated (some on-going)
  - Investigation yielded equipment specifications for Phase II expansion







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# PHASE II ACTIVITIES AND STATUS

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Phase II Production Line Technology**
  - High production rate processes in concept trials
- **Phase II Line Design**
  - Concept block diagram complete
  - Cross-functional teams set-up to design line
  - Detailed schedule being generated
  - Detailed cost estimate being generated

# PHASE II ACTIVITIES AND STATUS

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Quality Assurance Program**
  - Generated and customer-audited during Phase I program
  - All documents and procedures generated to yield fully integrated quality system
    - SOP's, FMEA's, process control plan, etc.
  - System of continuous improvement installed
    - Examines process metrics
    - Utilizes cross-functional teams to generate process improvement activities

## PHASE II ACTIVITIES AND STATUS

*Scale-up of Carbon/Carbon Bipolar Plates*

- **Quality Assurance Program (Cont.)**
  - Back-bone in place, but QA program will require modification in Phase II
    - New Control Plan, SOP's and FMEA's will be required to match high speed process
    - Updated customer audit will be required prior to Phase II line production

# PHASE II ACTIVITIES AND TIMELINE

## *Scale-up of Carbon/Carbon Bipolar Plates*

- **Overview of Phase II Line Schedule**
  - Project Planning – May 2003
  - Process Development – Complete by July 2003
  - Facility Demolition – Complete by August 2003
  - Set-up Equipment – Complete by October 2003
  - Commissioning – October to December 2003
  - Fully Functional – mid December 2003

# SUMMARY

## *Scale-up of Carbon/Carbon Bipolar Plates*

- Phase I Activities Complete
- Phase I Process Expanded to Meet Near-Term Product Demand
- Phase II Activities for Line Expansion Underway
- Expect Phase II Line Functional by December 2003

# CONCLUSIONS

## *Scale-up of Carbon/Carbon Bipolar Plates*

- PFCT is excited about bipolar plate opportunities and future markets
- PFCT is committed to bringing the technology to a profitable business in the next two years
- PFCT's believes our bipolar plate product will be superior to the competition in properties and competitive in cost, enabling fuel cell transportation technologies to enter the market in the coming years.